Using an Automated Speed, Steering, and Gap Control System and a Collision Warning System When Driving in Clear Visibility and in Fog

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FOREWORD

This report presents the results of one of a series of experiments that investigated driver performance in a generic Automated Highway System (AHS) configuration. The experimental research was conducted in an advanced driving simulator and investigated the effects of using an automated speed, steering, and gap control system (SSGCS) and a collision warning system (CWS) on driving behavior. When either the SSGCS or the CWS was on alone, it had no effect on average velocity or minimum following distance when driving performance was compared with a control group that did not have either system available. Nor did having had the SSGCS on have an effect on those variables when it was later disengaged. Other variables did show an effect of using the automated systems. This report will be of interest to engineers and researchers involved in Intelligent Transportation Systems and other advanced highway systems.

Sufficient copies of the report are being distributed to provide a minimum of two copies to each FHWA regional and division office, and five copies to each State highway agency. Direct distribution is being made to division offices.

A. George Ostensen, Director
Office of Safety and Traffic Operations
Research and Development

NOTICE

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16. Abstract

The effect on driving performance of using a *speed, steering, and gap control* system (SSGCS) and a *collision warning* system (CWS) was assessed in an experiment conducted in the Iowa Driving Simulator. Driving performance data were obtained from 52 drivers—32 of whom drove with both systems, and 20 controls who did not have access to either.

Results: (1) Driving while using the SSGCS. When the driver was using the SSGCS, there was no effect on speed; however, the driver's car tended to follow further behind the vehicle ahead than did the control-group drivers.

(2) Driving while using only the CWS. With the CWS engaged, drivers controlled both the speed and the steering more precisely than the control-group drivers. This may have occurred the driver was paying more attention than normal to the driving task. When using the CWS alone, the driver's speed was greater than that of the control drivers—particularly in the 100-m (328-ft) fog. This may have occurred because the driver was testing the CWS. Use of the CWS alone had no effect on the following-distance measures.

(3) Driving when the SSGCS and CWS were disengaged. When the driving performance of the experimental-group drivers—with both intelligent systems disengaged after the SSGCS had been activated at least once—was compared with that of the control-group drivers on steering instability, average velocity, and average actual gap, the results were mixed. There was no difference in minimum following distance between the experimental- and control-group drivers. The experimental-group drivers had more steering oscillations, making steering correction movements more frequently than the controls, but without changing their steering instability. They also reduced their velocity instability while increasing the number of velocity fluctuations, they were controlling speed more precisely than the controls, making more frequent corrections of smaller amplitude than the controls. These changes in driving performance may have occurred because the driver had to decide whether, and when, to use the SSGCS and CWS, and may have been paying much more attention than normal to the task of driving.

17. Key Words Automated highway system, human performance, driving simulation, traffic flow, automation, automated speed, steering, and gap control system, collision warning system, fog, intelligent vehicles, human factors.	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3

NOTE: Volumes greater than 1000 l shall be shown in m^3.

MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

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